CONSERVATION ASSESSMENT

For

Pannaria rubiginosa (Ach.) Bory

Originally issued
As Management Recommendations, 2003
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Reconfigured and updated, June 2007
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Preface

Since the transmittal of the original Management Recommendations for this species under the Survey and Manage Program in 2003, new information has been gathered regarding the taxonomy of the family *Pannariaceae*, raising questions regarding sites documented in the Pacific Northwest, Region 6 National Forests in particular. *Pannaria rubiginosa* sites identified in Lesher, et al. 2003 have been re-examined in the light of recent taxonomic investigation (Jørgensen 2000, Jørgensen et al. 2004, Jørgensen 2005). There have been some changes in the number and locations of *Pannaria rubiginosa*. This new information has been included in this document. This document applies to *Pannaria rubiginosa* populations that were reported in Washington, Oregon, and northern California in Lesher, et al. 2003 and as reported in Glavich et al. 2005a, b. Some new information on habitat management has been included in this document, and further updates should incorporate any other new information.

Management Considerations

Under the "Managing in Species Habitat Areas" section in this Conservation Assessment there is a discussion on "Management Considerations". "Management Considerations" are actions or mitigations that the deciding official can utilize as a means of providing for the continued persistence of the species' site. These considerations are not required, but are intended as general information that field level personnel could utilize and apply to site-specific situations.

Management of this species follows Forest Service 2670 Manual policy and BLM 6840 Manual direction. Additional information is available on the Interagency Special Status Species website: **www.fs.fed.us/r6/sfpnw/issssp/** .

Executive Summary

Species: *Pannaria rubiginosa* (Ach.) Bory

Taxonomic Group: Lichens (Rare Nitrogen fixing)

Other Management Status: Oregon Natural Heritage Information Center List 2 (taxa which are threatened, endangered, or possibly extirpated from Oregon, but are stable or common elsewhere); Oregon State Rank S2 (imperiled because of rarity, or because other factors demonstrably make it very vulnerable to extinction (extirpation), typically with 6-20 occurrences); Global Rank G4G5 (widespread, abundant, and apparently secure globally to demonstrably widespread, abundant, and secure globally) (Oregon Natural Heritage Information Center, 2004). *Pannaria rubiginosa* is not currently tracked by the Washington Natural Heritage program. The lichen working list for Washington is under revision and *P. rubiginosa* is currently being considered as a species to monitor for rarity rather than as a sensitive species, due to taxonomic questions and paucity of known sites. It is a Bureau Assessment species on the BLM Oregon Special Status Species list and is listed on the USFS Region 6 Regional Forester's Sensitive Species list.

Range: *Pannaria rubiginosa* is found in both southern and northern hemispheres ranging from cloud forests in Brazil to Costa Rica, to forested mountain islands in northern Mexico, to the Appalachians in the eastern United States. It is relatively abundant in Ireland and Scotland and appears to be restricted to the western portion of northern Europe, although historically found throughout Europe. The cause of the loss of range in Europe appears to be the effects of acid rain (Håkan, et al. 1999). The distribution of *Pannaria rubiginosa* in the Pacific Northwest is scattered and discontinuous, ranging from west of the Cascade Crest from British Columbia south to perhaps northern California. In the Pacific Northwest, there are eight known sites: 1) Schooner Cove, BC; 2) Kaloch vicinity on the Olympic peninsula, WA; 3) five collections near Heceta Beach, Eugene BLM District, OR; 4) Ona Beach State Park, OR; 5) Waldport, OR vicinity; 6) Goose Pasture, 7) Hall Lake, and 8) Sutton Creek areas of the Oregon Dunes National Recreation Area, Siuslaw National Forest, OR (Glavich, et al. 2005a; Doug Glavich, personal communication).

Specific Habitat: Current information suggests *Pannaria rubiginosa* is restricted to within a few kilometers of the ocean at or near sea-level (Glavich et al. 2005a). Habitat data are limited, but *P. rubiginosa* appears to grow in a variety of habitats. The most important microhabitat requirement may be high humidity, as open water is present at all sites. Known substrates are wood and bark of *Picea sitchensis*, *Salix hookeriana*, *Lonicera involucrata* and old woody *Cytisus scoparius* (Glavich et al. 2005a; Doug Glavich, personal communication). The largest known populations in this region are on the Oregon Coast in coastal scrub thickets on wet deflation plains (McCune and Geiser 1997; McCune et al. 1997).

Threats: The major threat to *P. rubiginosa* is loss of populations resulting from loss of habitat and loss of substrate. Invasive species, such as French broom, compete with important native shrub species that provide habitat and substrate for *P. rubiginosa.* The removal of invasive plants using mechanical means or herbicides have the potential to disturb *P. rubiginosa* habitat through accidental removal of or damage to native trees and shrubs. Activities including recreational impacts and land development can damage or remove colonized substrate and alter microclimate. Air pollution such as acid rain can kill pollution intolerant lichen species. Pollution tolerant lichens may increase with increased pollution and displace other lichen species such as *P. rubiginosa*. Global warming may result in more frequent extreme high tides and altered seasonal weather patterns thus changing species composition on wet deflation plains. Due to the rarity of *P. rubiginosa* in the PNW, collection of specimens is also a potential threat.

Management Considerations

- Determine the extent of the local population and habitat area with a field visit.
- Manage species habitat areas to maintain the ecological conditions associated with *P. rubiginosa* including stand structure, occupied and potentially suitable substrate, and associated microclimate conditions. Maintain current habitat conditions, and allow occupied stands to develop naturally.
- Restrict collection of specimens where the species is rare or of limited abundance.

Data Gaps and Information Needs

- Determine if additional populations of *P. rubiginosa* exist in areas identified as potentially suitable habitat.

- Determine the distribution and ecology of *Pannaria rubiginosa.*
- Revisit known sites to verify the status of known populations, determine the extent of the populations, and characterize the ecological conditions.
- Determine the degree of association of *P. rubiginosa* with late-successional and old growth forests.
- Resolve taxonomic issues and provide conclusive taxonomic agreement of Pannariaceae within the Pacific Northwest.

I. Natural History

A. Taxonomy and Nomenclature

Pannaria rubiginosa (Ach.) Bory was originally described by Acharius in the 19th century. This species is treated in the monograph of the Pannariaceae in Europe (Jørgensen 1978). It is in the order Lecanorales, suborder Peltigerineae, family Pannariaceae (Tehler 1996).

Pannaria rubiginosa is PD+ (due to the presence of the chemical pannarin) and is found on coastal deflation plains from the central Oregon coast to the coast of British Columbia. There are some taxonomically puzzling PD- specimens from inland Oregon that have been mistaken for *P. rubiginosa*. In 2000, Jørgensen identified these inland sites as *P. malmei*. Since then, Jørgensen and Sipman, 2004 concluded that *P. malmei* is not found in North America. What Jørgensen had identified in his 2000 survey of North American species as *P. malmei,* he now believes is actually a different species, called *P. rubiginella* (Jørgensen and Sipman 2004, Jørgensen 2005). According to Jørgensen and Sipman 2004, *P. rubiginella* is restricted to humid forests and shrubbery along the Pacific coast from Chile to British Columbia. However, the habitat described by Jørgensen for *P. rubiginella* does not fit the PD- specimens found at Oregon's inland sites, which leaves the question as to what species of PD- *Pannaria* is found inland in Oregon. According to Glavich (personal communication, 2007) these inland sites can be called *P. cf. rubiginella*. There is a possibility that the inland sites could be an undescribed Pannaria, and further analyses of the thalli using Thin Layer Chromatography could help with identifying them (Glavich, personal communication, 2007).

Both *Fuscopannaria leucostictoides* and *P. rubiginella*) have been mistaken for *P. rubiginosa*. Both *F. leucostictoides* and *P. rubiginella* have apothecia with a "ringed" look due to the thalline margin around the ascocarp. Other "Pannaria" in the PNW are usually not confused because they are sorediate (no apothecia) or lack thalline margins on the apothecia. Please refer to the Appendix: Summary of Taxonomic History of the *Pannaria rubiginosa* complex for taxonomic descriptions of *P. rubiginella*, *P. malmei,* and *P. rubiginosa*.

B. Species Description

1. Morphology and Chemistry

Pannaria rubiginosa is an inconspicuous lichen, readily recognized by its small foliose rosettes and elongated lobes, and brown to red-brown apothecia with an even thalline rim (Figure 1) (McCune and Geiser 1997). It has a PD+ orange-red reaction, unique among other Pacific Northwest *Pannaria* species. The thallus is blue-gray; lobes are narrow and can appear distinctly squamulose, especially at the center. In exposed sites, the thallus becomes darker and olivaceous (Purvis *et al*. 1992).

Technical Description: Thallus foliose, forming rosettes to 2-3 cm in diameter with marginal lobes; upper surface whitish gray-blue to brown or olive; lobes 3-4 mm x 7-8 mm, deeply indented and mostly concave with thick, pale, ascending margins; surface smooth, more or less faintly scabrid or occasionally thin pruinose; hypothallus fibrous, well developed, obscure or sometimes extending as a blue-black zone surrounding the thallus. Photobiont is the cyanobacterium Nostoc. Apothecia 0.5-1.5 mm in diameter, frequent; disc red-brown; thalline exciple prominent, persistent, often crenulate. Ascospores 15-19 μm x 9-10 μm, with perispore

20-24 μm x 10-12 μm, colorless, ellipsoid; perispore uneven, acuminate at one or both ends. Thallus PD+ orange-red (pannarin) (Purvis *et al*. 1992:421).

2. Reproductive Biology

Pannaria rubiginosa reproduces sexually by ascospores; asexual propagules are unknown.

3. Ecological roles

Little is known about the ecological role of *P. rubiginosa* in the Pacific Northwest. It is a nitrogen-fixing species.

C. Range and Sites

Pannaria rubiginosa is found in both southern and northern hemispheres ranging from cloud forests in Brazil to Costa Rica, to forested mountain islands in northern Mexico, to the Appalachians in the eastern United States. It is relatively abundant in Ireland and Scotland and appears to be restricted to the western portion of northern Europe, although historically found throughout Europe. The cause of the loss of range in Europe appears to be the effects of acid rain (Håkan, et al. 1999). The distribution of *Pannaria rubiginosa* in the Pacific Northwest is scattered and discontinuous, ranging from west of the Cascade Crest from British Columbia south to perhaps northern California. In the Pacific Northwest, there are eight known sites: 1) Schooner Cove, BC; 2) Kaloch vicinity on the Olympic peninsula, WA; 3) five collections near Heceta Beach, Eugene BLM District, OR; 4) Ona Beach State Park, OR; 5) Waldport, OR vicinity; 6) Goose Pasture, 7) Hall Lake, and 8) Sutton Creek areas of the Oregon Dunes National Recreation Area, Siuslaw National Forest, OR (Glavich, et al. 2005a; Doug Glavich, personal communication). The Waldport, OR vicinity site has not been relocated (Marty Stein, personal communication). All sites have been re-examined with the exception of two historic sites in Pacific and Pierce in Washington. Vouchers from these sites are held by the New York Botanical Gardens, and they have not been re-examined since the discovery of *P. rubiginosa* in the United States. It is expected that the Pierce County specimen is not *P. rubiginosa* given its inland location. Another location, from Kittitas County, has no site location information making it inadequate for relocating the site. In addition, no voucher or collection information was found during the preparation of this Conservation Assessment. There are no collections of *P. rubiginosa* in the Cryptogamic Collection at the University of Washington, according to Katherine Glew, Assistant Curator (pers. comm.). It appears that the only confirmed collection of *P. rubiginosa* in Washington is that of Martin Hutten from the Olympic Peninsula. The site at Schooner Cove, B.C. is outside the Northwest Forest Plan area. The previously reported (Lesher, et al. 2003) Fisherman's Bend site on the North Santiam was determined to be *P. malmei* (Bruce McCune, personal communication), but it is likely *P. rubiginella*. Glavich et al. found *P. rubiginella* (identified as *P. malmei* at the time) at Pt. Reyes National Seashore, Marin County, CA. *Pannaria rubiginella* is thought to be a coastal species found in cool moist habitats (Jørgensen & Sipman 2004; Jørgensen 2005), and its rarity is not known.

D. Habitat Characteristics and Species Abundance

Pannaria rubiginosa appears to be rare in the Pacific Northwest. Current information suggests it is restricted to within a few kilometers of the ocean at or near sea-level (Glavich et al. 2005a). Habitat data are limited, but *P. rubiginosa* appears to grow in a variety of habitats. The most important microhabitat requirement may be high humidity, as open water is present at all sites.

Known substrates are wood and bark of *Picea sitchensis*, *Salix hookeriana*, *Lonicera involucrata,* and old woody *Cytisus scoparius* (Glavich et al. 2005a; Doug Glavich, personal observation). The largest known populations in this region are on the Oregon Coast in coastal scrub thickets on wet deflation plains (McCune and Geiser 1997; McCune *et al*. 1997).

II. Current Species Situation

A. Status History

Pannaria rubiginosa is an ORNHIC List 2 species, meaning that it is considered threatened, endangered or possibly extirpated in Oregon, but is common or stable elsewhere. Its Natural Heritage ranking for Oregon is S2, meaning that this lichen is imperiled because of rarity or because other factors demonstrably making it very vulnerable to extinction, typically with 6-20 occurrences. The global ranking is G4G5, meaning that it is widespread, abundant, and apparently secure globally to demonstrably widespread, abundant, and secure globally. *Pannaria rubiginosa* is not currently tracked by the Washington Natural Heritage program. The lichen working list for WA is under revision and *P. rubiginosa* is currently being considered as a species to monitor for rarity rather than as a sensitive species. *Pannaria rubiginosa* was considered at risk under the Northwest Forest Plan because of its presumed rarity in the range of the northern spotted owl. At the time of the FEMAT viability rating (USDA and USDI 1994a) and additional species analysis (USDA and USDI 1994b), this species was reported from only two sites in the region. Viability concerns were also noted for this species because of its presumed sensitivity to air pollution, inferred by the known sensitivity of other nitrogen-fixing lichens. The pollution sensitivity of *P. rubiginosa* is unknown, however. The species is identified by BLM Oregon as Bureau Assessment and is listed on the USFS Region 6 Regional Forester's Sensitive Species list.

B. Major Habitat and Viability Considerations

The major viability considerations for *P. rubiginosa* in the Pacific Northwest are loss of populations resulting from management or other activities that affect the populations or their habitat.

C. Threats to the Species

The major threat to *P. rubiginosa* is loss of populations resulting from loss of habitat and loss of substrate. Invasive species, such as French broom, compete with important native shrub species that provide habitat and substrate for *P. rubiginosa.* The removal of invasive plants using mechanical means or herbicides have the potential to disturb *P. rubiginosa* habitat through accidental removal of or damage to native trees and shrubs. Activities including recreational impacts and land development can damage or remove colonized substrate and alter microclimate. Air pollution such as acid rain can kill pollution intolerant lichen species. Pollution tolerant lichens may increase with increased pollution and displace other lichen species such as *P. rubiginosa*. Global warming may result in more frequent extreme high tides and altered seasonal weather patterns thus changing species composition on wet deflation plains. Due to the rarity of *P. rubiginosa* in the PNW, collection of specimens is also a potential threat.

D. Distribution Relative to Land Allocations

In Oregon and Washington, four populations of *Pannaria rubiginosa* are found on BLM or Forest Service lands: Sutton Creek, Goose Pasture, and Hall Lake of the Oregon Dunes National Recreation Area, Siuslaw National Forest, administratively withdrawn lands; and at Heceta Dunes Area of Critical Environmental Concern, Eugene District BLM, which is the largest population in the PNW. On State Lands, *P. rubiginosa* is found at Ona State Park, Lincoln County. There is an additional collection site documented from the Waldport area, no ownership information is available (Glavich, et al. 2005a) and the site was not relocated during a recent visit to *P. rubiginosa* sites on the Oregon Coast (Marty Stein, pers. comm.). In Washington, *Pannaria rubiginosa* is found at one site on protected lands in Olympic National Park (Glavich, et al. 2005a).

III. Management Goals and Objectives

Management for this species follows FS Region 6 Sensitive Species (SS) policy (FS Manual 2670), and/or BLM Oregon and Washington Special Status Species (SSS) policy (6840).

For Oregon and Washington BLM administered lands, SSS policy details the need to manage for species conservation. For Region 6 of the Forest Service, SS policy requires the agency to maintain viable populations of all native and desired non-native wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands. Management "must not result in a loss of species viability or create significant trends toward federal listing" (FSM 2670.32) for any identified SS.

IV. Habitat Management

A. Lessons from History

Based on observations in Europe, concerns have been expressed about the sensitivity of this species to air pollution. Many lichen species are known to be sensitive to air pollution, and lichen population declines attributed to air pollution have been documented in Europe and North America (Rao and LeBlanc 1967, Skye and Hallberg 1969, Sigal and Nash 1983, Gilbert 1992). Many nitrogen-fixing lichen species are especially sensitive to air pollution, particularly sulfur dioxide (Wetmore 1983). The sensitivity of *P. rubiginosa* to air pollution is unknown, but, based on the known sensitivity of other nitrogen-fixing lichens, *P. rubiginosa* is likely also to be sensitive to air pollution.

The decline of lichens in Europe has resulted in listing threatened species. Sweden has a "red list" of lichens that are threatened with extinction because of air pollution and habitat degradation (Thor 1990); *Pannaria rubiginosa* is on this list as endangered (Databanken for hotade arter och Naturvardsverket 1991).

Very little is known about the ecology of *P. rubiginosa* in the Pacific Northwest, or how past actions have affected its distribution or persistence. The greatest risks to *Pannaria rubiginosa* in the Pacific Northwest are habitat loss and loss of substrate. Risks noted by land managers with *P. rubiginosa* sites include: park improvement projects (sewer lines), recreational Off Highway Vehicle use, invasive species, natural processes (dune movement, flooding, erosion), trail

maintenance, weed treatment (non-selective herbicide treatments), and hiker traffic. Successful management has been to re-route planned projects away from *P. rubiginosa* sites.

B. Identifying Species Habitat Areas

All known sites of *P. rubiginosa* on lands administered by the Forest Service and BLM in Oregon and Washington are identified as areas where the information presented in this Conservation Assessment may be applied. A species habitat area is defined as suitable habitat occupied by or adjacent to a known population.

C. Managing in Species Habitat Areas

Consider the following:

- Determine the extent of the local population and habitat area with a field visit.
- Manage species habitat areas to maintain the ecological conditions associated with *P. rubiginosa* including stand structure, occupied and potentially suitable substrate, and associated microclimate conditions. Maintain current habitat conditions, and allow occupied stands to develop naturally.
    - Avoid activities such as vegetation removal, trail placement, and non-selective weed treatments in proximity to the population. Avoidance areas can range from approximately 50 feet minimum for new trail placement, off road highway vehicle use, infrastructure improvement projects, and non-selective weed treatments. Avoidance of these populations when conducting land management activities seems appropriate given the rarity of the species, and consistent with the protective land allocations the current Forest Service and BLM populations fall within.
    - Where invasive weeds pose a threat, aggressively treat the weeds through hand pulling or targeted chemical applications (where allowed).
    - Re-route trails and OHV use areas when use conflicts appear to result in potential impacts to populations.
    - Avoid disturbance to occupied substrate.
- Restrict collection of specimens where the species is rare or of limited abundance.

V. Research, Inventory, and Monitoring Opportunities

The objective of this section is to identify opportunities for additional information which could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. The inventory, research, and monitoring identified below are not required. These recommendations should be addressed by a regional coordinating body.

A. Data Gaps and Information Needs

- Determine if additional populations of *P. rubiginosa* exist in areas identified as potentially suitable habitat.
- Determine the distribution and ecology of *Pannaria rubiginosa.*
- Revisit known sites to verify the status of known populations, determine the extent of the populations, and characterize the ecological conditions.

- Determine the degree of association of *P. rubiginosa* with late-successional and old growth forests.
- Resolve taxonomic issues and provide conclusive taxonomic agreement of *Pannaria* within the Pacific Northwest.

B. Research Questions

- What habitat characteristics and ecological conditions are necessary for the establishment of *P. rubiginosa* propagules and survival of established thalli?
- What are the dispersal mechanisms and dispersal distances of *P. rubiginosa*?
- Is *P. rubiginosa* sensitive to air pollution?
- What are the mechanisms and rates of reproduction and growth for this species?
- What is the genetic diversity of this species within its local populations and across the region?

C. Monitoring Opportunities and Recommendations

- If management activities occur adjacent to known sites, monitor the population to determine response to treatment and effects on the population.
- At sites without management actions occurring, consider longer term monitoring to detect if global warming or pollution effects are noticed in the population.

VI. Acknowledgements

Thanks to Terry Fennell, Doug Goldenberg, Bruce McCune, Marty Stein, Katie Glew, Martin Hutten, and Jean Ponzetti for sharing information about *P. rubiginosa.*

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VIII. Glossary

Documented Occurrence

Generically, it is the location of an individual of a species. Multiple occurrences may equal one or more Element Occurrence. Documented occurrences are at least 100 m apart. A physical record exists to indicate that the species either occurred historically or currently exists in the area defined. See also Site (Occupied).

Element Occurrence

An area of land/or water in which a species is, or was, present (Master et al. 2001). An element occurrence should have practical conservation value for the species or ecological community as evidenced by historical or potential continued presence and/or regular recurrence at a given location. Often corresponds with the local population, but, when appropriate, may be a portion of a population or a group of nearby populations.

Habitat Disturbance
Natural or human caused disturbances that likely may have impacts on the species habitat, its life cycle, microclimate, or life support requirements**.**

Management Considerations
Potential management activities designed to achieve the conservation of a species at a site. Management Considerations are not mandatory.

Monitoring
The collection of information used to determine if management actions are meeting objectives of standards and guidelines and if they comply with laws and management policy. Monitoring is used to determine if standards and guidelines are being followed (implementation monitoring), if they are achieving the desired results (effectivenss monitoring), and if underlying assumptions are sound (validation monitoring). Monitoring involves collecting information on a sampling basis, provides standardized data, and occurs at multiple levels and scales.

Persistence
The likelihood that a species will continue to exist or occur within a geographic area of interest over a defined period of time. Includes the concept that the species is a functioning member of the ecological community of the area**.**

Site (Occupied)
The location where an individual or population of the target species (taxonomic entity) was located, observed, or presumed to exist and represents individual detections, reproductive sites, or local populations. Specific definitions and dimensions may differ depending on the species in question and may be the area (polygon) described by connecting nearby or functionally contiguous detections in the same geographic location. This term also refers to those located in the future (USDA and USDI 1994a). See Documented Occurrence and Element Occurrence.

Range
The limits of the geographic distribution of a species.

Species Habitat Area
The geographic area identified that requires management to provide for the continued persistence of the species. May include occupied and unoccupied habitats and sites.

Suitable Habitat
Abiotic and biotic environmental conditions within which an organism is known to carry out all aspects of its life history.

Viable Populations
A wildlife or plant population that contains an adequate number of reproductive individuals appropriately distributed on the planning area to ensure the long-term existence of the species (USDA and USDI 1994a). For invertebrate, non-vascular plant, and fungi species, “appropriately distributed” may include the following conditions: the species is well-distributed, the species is distributed with gaps, or the species is restricted to refugia. Refer to page 123 in Chapter 3 and 4 of the FSEIS for the Northwest Forest Plan for further clarification.

Well-distributed
Distribution of the species is sufficient to permit normal biological function and species interactions. This distribution considers life history characteristics of the species and the habitats for which it is specifically adapted.

Wet deflation plain
Low hills, or fore dunes are formed parallel to the edge of the ocean. They can be 20-30 feet high. As winds strip away the sand east of the fore dune, the area, called a deflation plain, is scoured or deflated to permanently wet sand where water loving plants thrive.
(From http://gorp.away.com/gorp/resource/us_nra/or/nat_dune.htm)

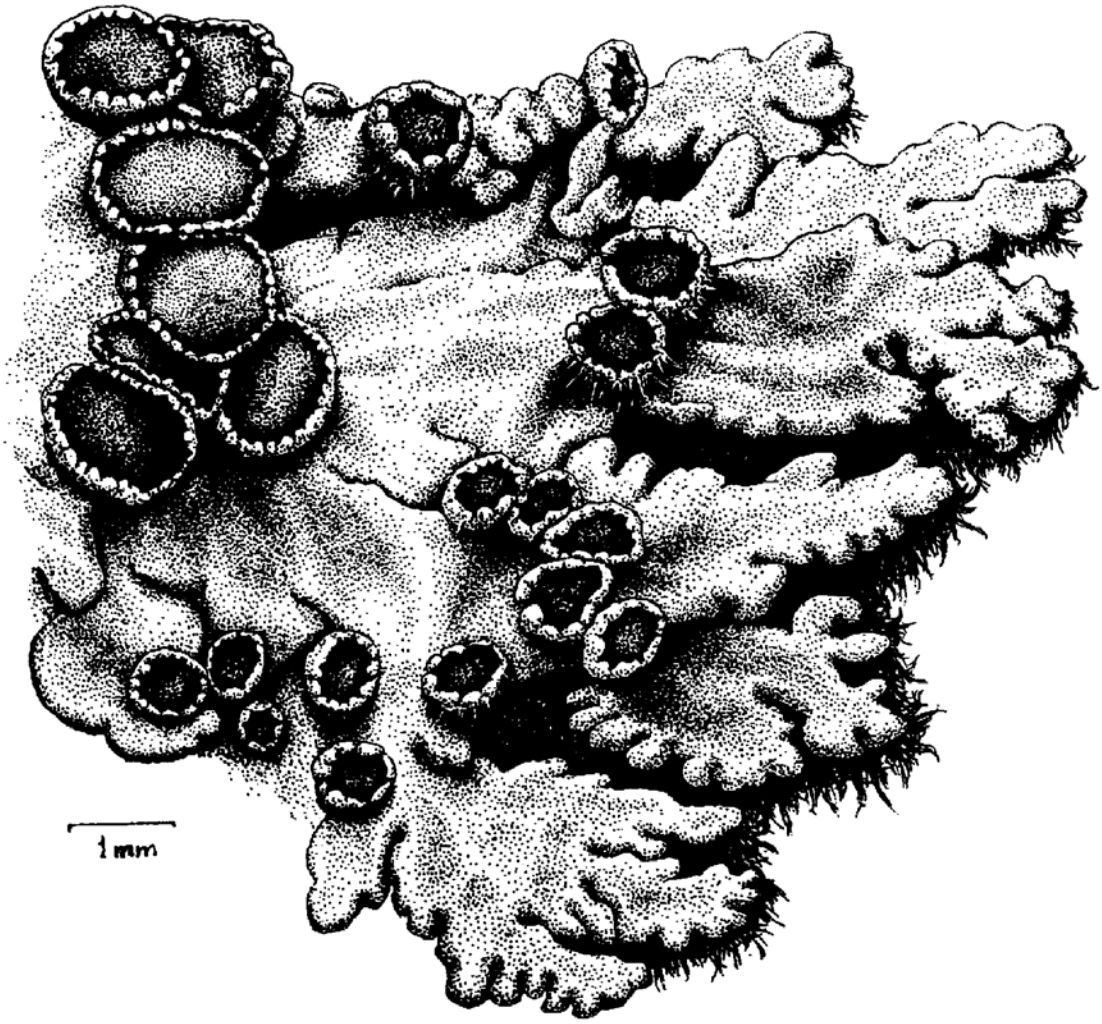
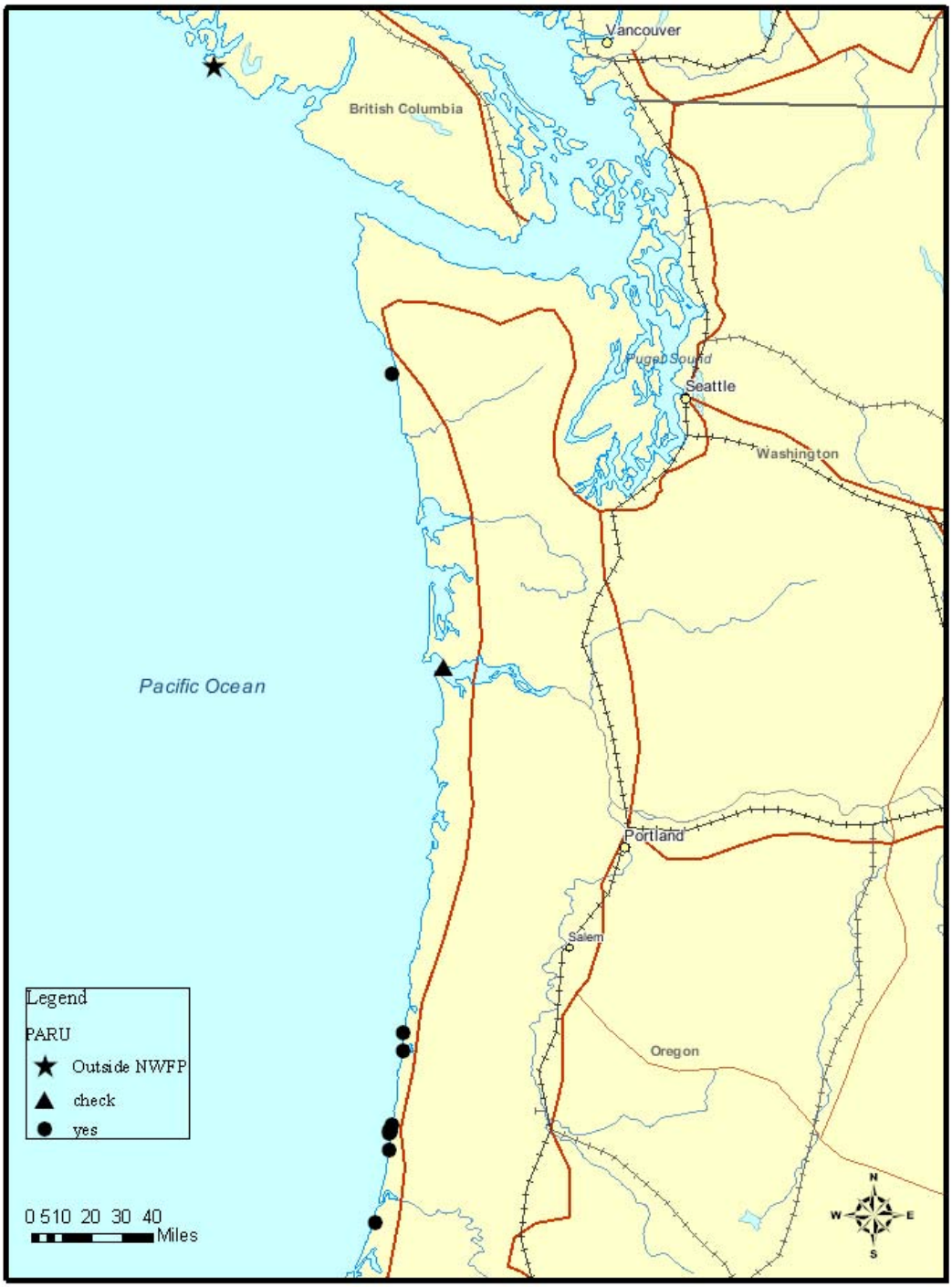


Figure 1. Line drawing of *Pannaria rubiginosa* by Alexander Mikulin.

Figure 2. Approximate range and known sites of *Pannaria rubiginosa* in the Pacific Northwest, including the Pacific County site that needs verification as *P. rubiginosa*



Appendix 1: Summary of Taxonomic History of *Pannaria rubiginosa* complex

Year	Citation	Taxonomic Description of P. rubiginosa	Look-alikes	Notes
1978	Jorgensen, P.M. The lichen family Pannariaceae in Europe. [Studies in the lichen family Pannariaceae. I. The European species.] Opera Botanica 45: 1-124.	Thallus without isidia or soredia. Upper surface never ridged. Thallus rosette-formed, 2-3 cm diameter, marginal lobes 7-8 mm long, whitish blue to fawn, scabrid or slightly pruinose, especially at apices. PD +/- orange-red due to presence of pannarin(a few specimens PD-). Medulla rarely more than 100 (70-100) micrometers, of lax randomly arranged hyphae. Apothecia with a thalline margin, frequent, 0.5-1.5 mm diameter. Margin prominent often silvery white and crenulate, but not white-felted tometose. Apothecial disc red-brown. Hymenium I+ persistently deep blue. Epispores acuminate at apices.	P. leucosticta (now called Fuscopannaria leucostictoides) has been confused with P. rubiginosa in Europe. On this continent only stunted forms of P. rubiginosa, paricularly in the mediterranean region, really cause confusion with it. These two species are often also confused in America. P. leucostica group (Fuscopannaria leucostictoides) is easily distinguished by the white felted-tomentose margins of the apothecia, chestnut brown squamules, and apiculate epispore. P. conoplea (sorediate) and P. tavaresii (isidiate) are considered species pairs, with P. rubiginosa as the basic species in the group.	P. malmei was not described in Jorgensen's monograph.
2000	Jorgensen, P.M. Survey of the lichen family Pannariaceae on the American continent, north of Mexico. The Bryologist 103(4), pp. 670-704.	Thallus foliose, forming orbicular rosettes, to 3-5 cm. Upper surface partly pruinose or scabrous, bluish gray to fawn, lobes with raised margins, mostly PD+ orange (pannarin) throughout. Apothecia frequent, particularly centrally. Ascospores hyaline simple, broadly ellipsoid, (with perispore)	The morphologically similar species P. malmei has smaller spores, a smaller flatter thalli with a more prominent hypothallus. P. malmei is richly fertile and strongly pruinose. It is weakly PD+ only on the cortex. It replaces P. rubiginosa in the warmest driest parts of the Pacific coast. P. leucostichtoides looks like small specimens of P. malmei (and P. rubiginosa). Sterile PD- thalli of P. rubiginosa and P. malmei can always be separated from Fuscopannaria leucostictoides by the absence of atranorin and terpenoids. F. leucostictoides is mostly corticolous on conifers (although it can be found on deciduous trees and rock).	P. malmei, P. rubiginosa and P. leucostictoides can look alike. All are considered part of the N American lichen flora.
2004	Jorgensen, P.M. and H. J. M. Sipman. A revision of the Pannaria rubiginosa complex in South America. Nova Hedwigia 78(3-4) pp.311-327.	Thallus foliose, forming rosettes, to 3-4 cm diameter. Marginal lobes 3-4 mm wide, 150-250 micrometers thick, concave with upturned margins. Upper surface partly pruinose or scabrous, whitish blue to fawn. Prothallus variously developed, but never forming cushions. Apothecia scattered to 1.5 mm diam.; disc orange-brown. Ascospores colorless simple, rugose, ellipsoid, 15-20x10-12 micrometers.Chemistry PD+ orange (pannarin).	P. rubiginella. Thallus squamulose, forming rosettes 3(4) cm wide, blue-grey, faintly pruinose or not; marginal lobes flat, 150-200 micrometers thick, broadly enlarged to 2 mm diam. on variously developed prothallus. Apothecia to 2 mm diam., often plentiful centrally; disc brownish orange. Ascospores simple, colorless, rugose, broadly ellipsoid, 10-15x8-9 micrometers. PD+ weakly orange or negative, in upper cortex only.	In Jorgensen 2000, P. rubiginella was incorrectly lumped with P. malmei, which is browner, more leafy and a subtropical species. P. rubiginella is a mainly corticolous species confined to humid forests or shrubbery, along the Pacific coasts, from Juan Fernandez, Chile to Queen Charlotte Isl., Canada, avoiding tropical areas.
2005	Jorgensen, P.M. Additions to the Pannariaceae of North America. The Bryologist 108 (2) pp. 255-258.		P. rubiginella. is smaller sized, flat, nearly crustose lobes; smaller spores; and weak PD reaction (often seemingly negative) that was misidentified by Jorgensen 2000 as P. malmei	P. rubiginella was misidentified as P. malmei in Jorgensen's 2000 Pannariaceae treatment. P. malmei is a much more tropical species not known to occur in North America. P. rubiginosa is generally larger and has a PD+ orange reaction.

Appendix 2: Site information and verification notes

Site Name/ FLOBS_NUM	Collector	VISIT DATE	Location	Land Ownership	Habitat	Substrate	Verfication Not
Goose Pasture	D.A. Glavich	9/12/2006	about 200 meters northeast of the Goose Pasture OHV staging area in the Oregon Dunes National Recreation Area and near main dunes entrance road in the area	Siuslaw NF	shrubland taken over by *Cytisus scoparium* shrubs on the edge of Sitka spruce/Shore pine dune forest	old *Cytisus scoparium* branch	PD + orange in b cortex and medul D.A. Glavich
Hall Lake	D.A. Glavich	9/12/2006	in first deflation plane due west of Hall Lake in the Oregon Dunes National Recreation Area. In large willow clump at the far west end of the deflation plain	Siuslaw NF	Willow dominated deflation plane with shore pine and sitka spruce coming in.	old willow branch	PD + orange in b cortex and medul D.A. Glavich
Heceta Beach 200688850138681127	McCune and Neitlich	11/13/1994	Just inland from Heceta Beach	Eugene BLM		Salix hookeriana	Geiser pers. communication v VanNorman
Heceta Beach 2006888501378981128	McCune	10/1/1994	Just inland from Heceta Beach	Eugene BLM	Dune and wetland mosaic, often with dense shrubs and broken Pinus contorta and PISI forest.	old Salix branches	Geiser pers. communication v VanNorman
Heceta Beach 324521010556	McCune and Neitlich	11/13/1994	Heceta Dunes	Eugene BLM			Glavich et al. 200
Waldport vicinity 20068885244881300	Bailey	1/1/1995	Waldport. Glavich found voucher in McCune herbarium and verified (5/22/07). However, site revisits have not relocated the species.	Siuslaw NF?			Confirmed by D. Glavich
Sutton Creek 200688852342481299	Mikulin	8/8/2000	Sutton Creek Trail	Siuslaw NF	90 year-old Sitka Spruce/lodgepole stand with a dense shurb understory by riverbank	On PISI wood	Glavich et al. 200
Kaloch vicinity 200688852529781302	Hutton	2/10/2000	Collection Area on immediate coast just West of Hwy 101 between Hoh and Clearwater	Olympic National Park	Sitka spruce forest bordering riparian ALRU	In salt spray zone on trunk of PISI	Glavich et al. 200
41031.10285 Long Beach, WA	G. Howard	1/1/1928	Mapped as Fort Columbia State Park, WA. at the mouth of the Columbia River, but location information suggests “Long Beach”. Needs site revisit.	State Park			Voucher likely h New York Botan Gardens

114040010556	Mark Boyll	6/28/1999	Mapped as Camp Creek, south of Peavine Mountain, Mt.Hood National Forest	Mt Hood NF			Vouchers determ to be *Fuscopanna leucostictoides* b Doug Glavich, Ju 12, 2007. No furt verification need
338963010556	McCune and Neitlich	5/3/1995	Mapped as due west of Harrisburg, Georges Knob	Eugene BLM			McCune indicate PARU is not in th database or origi datasheets for thi survey (Glavich, personal communication, 2007). No furthe to retain this as a potential site, or verify.
Schooner Cover 200688852592281303	T. Goward	1/1/1983	Schooner Cove, Vancouver BC. 12 km SE of Torofino on SW Vancouver Island		Sitka spruce at the edge of a dune along beach.	Lower branch of Picea	Geiser pers. communication v VanNorman
Ona Beach 200688852465781301	J. Riley	1/1/1901	Ona Beach State Park, Beaver Creek. Replaced incorrect UTME	State Park	Riparian	Lonicera involucrata	Glavich et al. 200
Pierce County, WA	G. Howard	1940	Trail to Seattle Park; not included on map in Figure 2 as it is unlikely this site is PARU	Mt. Rainier NP			Voucher likely h New York Botan Gardens; inland s not likely to be P
Kittitas County, WA			Unknown; no location information. This site is not included on map in Figure 2.				No location, vou or collection information avail Unable to assess validity of this site/collection.